CLUB OF BOLOGNA PRIZE

Giuseppe Pellizzi International Best PhD Prize

Specification, design and evaluation of an automated agrochemical traceability system

Sven Peets

Supervisors Prof. R. J. Godwin, Dr. D. W. K. Blackburn

Cranfield University/School of Applied Sciences

✉: Harper Adams University College, Newport, Shropshire TF10 8NB, United Kingdom

☎: + 44 1952 815143 Email: speets@harper-adams.ac.uk

Introduction

Traceability through all the stakeholders in food production is an issue of increasing importance, being specifically required by the regulations for food safety and quality (EC 178/2002), and for compliance with environmental protection. The agricultural market perceives a need for systems and technologies to automate the currently manual process of producing records of agrochemical inputs loaded into a sprayer.

Design and construction

A novel prototype Automated Agrochemical Traceability System (AACTS) to identify and weigh agrochemicals as they are loaded into crop sprayer has been designed, constructed, fitted to a machine and evaluated with commercial operators (Figure 1 & 2). The functional blocks of the system are a 13.56 MHz RFID reader, 1.4 litre self cleaning weighing funnel mounted on a 3 kg load cell, a user interface with a screen and three user command buttons (Yes, No, Back), and a progress bar made of 8 coloured LED's (green, amber, red).

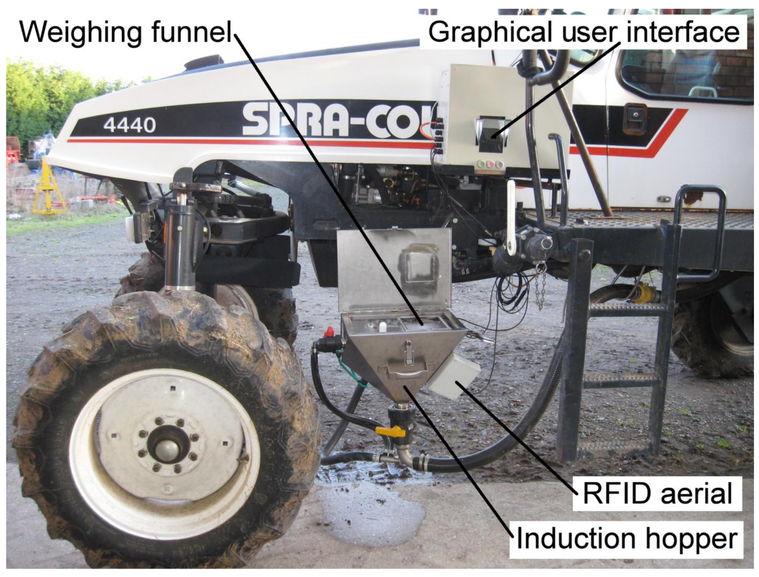

Figure 1. AACTS fitted to a crop sprayer

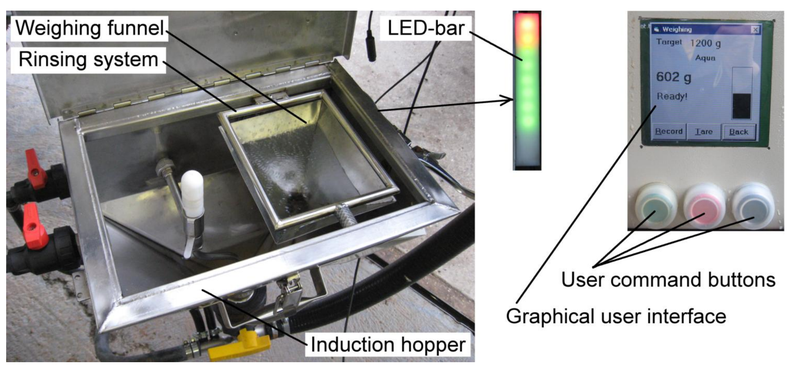

Figure 2. Quantification system within the induction hopper and user interface

The system is able to trace individual agrochemical containers, associate the product identity with national agrochemical databases, quantify the required amount of product, assist the sprayer operator and control workflow, generate records of sprayer inputs and interoperate with (recommending extensions to) task management standards as set out in ISO 11783-10.

Digital signal conditioning

The evaluation of the quantity weighing has demonstrated that with such a system, the principal noise component is in the range of 33–83 Hz, induced by the operating tractor engine (Figure 3). A combined 3 Hz low pass digital filter with a second stage rolling mean of 5 values improves performance to allow a practical resolution of 1 gram (engine switched off) to 3.6 grams (sprayer fully operational) with a response appropriate to suit human reaction time.

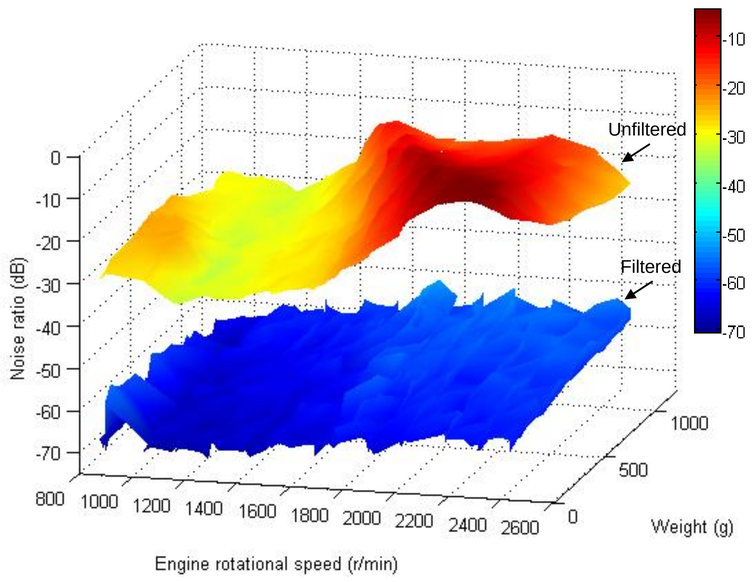

Figure 3. The effect of 3 Hz cut off low pass filter on the noise ratio

Evaluation of operator performance

An experiment with 10 sprayer operators has demonstrated there is no consistent regression between the speed and error. Overall, 92% of the cases are measured within ±5% error (Figure 4).

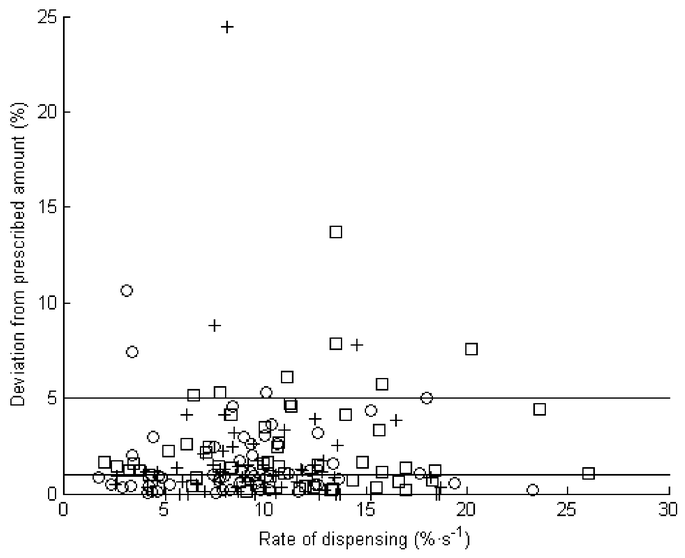

Figure 4. The relation between speed and error for the AACTS: water (+), paste (□), granules (sugar) (○)

The dispensed amounts (100.36% of target) and recorded (100.16%) are in accordance with prescribed values (100%; $LSD_{(5\%)}$ 2.166%), where amounts dispensed by manual methods (92.61%) differ significantly from prescribed and recorded value (100%). The regression line on Figure 5 for automatic method shows a closer fit to desired characteristic ($y=x$) and stronger dependency between variables than for manual method ($y = 0.9324x$, $R^2 = 0.9080$).

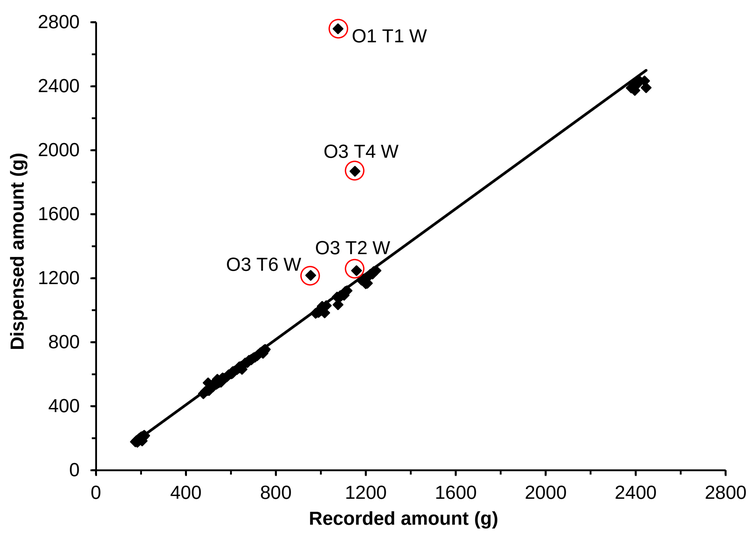

Figure 5. Dispensed amount against recorded amount with automatic method, $y = 1.0217x$, $R^2 = 0.9370$ (O – operator, T – task, W – water)

The AACTS delivers a statistically similar work rate (211.8 s/task) as manual method (201.3 s/task; Δt = 10.5 s/task; $LSD_{(5\%)}$ 28.2 s/task) in combined loading and recording cycle. Considering only the loading time (181.2 s/task) of manual method, the difference is 30.6 s/task ($LSD_{(5\%)}$ 30.1 s/task) (Figure 6). In practice this difference is believed to be marginal compared to the time required to load the water, random external events during the spraying session and in time moving, checking and storing paper records.

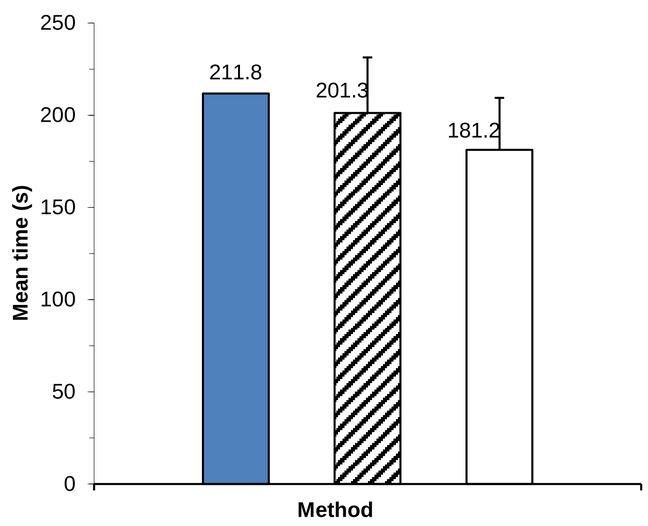

Figure 6. Speed of operation by method per task: auto (■), manual loading+recording (◪), manual loading (□), error bars represent $LSD_{(5\%)}$

The AACTS was rated to be safer than the manual method regarding operator health and safety and risk of spillage. All operators who evaluated the AACTS were interested in purchasing such a system.

RFID agrochemical label

The work confirmed that an RFID system was a robust and reliable method for the automated identification of agrochemical containers. A format has been proposed as a standard for data held on RFID tag applied to agrochemical containers. This uniquely identifies single packs whilst associating the product type with existing national agrochemical databases. The proposed format allows verification of authenticity and current chemical registration, while being operable on-sprayer without live access to an international item level database.

Integration into ISO 11783

The AACTS follows ISO 11783 task management logic where a job is defined in a prepared electronic task file. It is proposed to extend the ISO 11783-10 task file to integrate the records provided by AACTS by handling the tank loads as individual products resulting from loading task and allocating them to spraying tasks.

Recommendations

It is recommended to produce a production prototype following the design methodology, analysis techniques and performance drivers presented in this work and develop the features of user interface and records of tank content into software for ISO 11783-10 cabin task controller to deliver business benefits to the farming industry. The results with RFID encourage the adoption of RFID labelling of agrochemical containers.

The research program was funded by AGCO Corp., Douglas Bomford Trust and Patchwork Technology Ltd.

eima international 2012

FEDER UNACOMA
Federazione Nazionale Costruttori Macchine per l'Agricoltura